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SURVEY

DES Sky Camera (Cloud Camera)

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Cloud Camera Review
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SkyCam Purpose

An All-Sky Camera is needed in order to:

- Provide real-time estimates of the sky conditions for survey strategy
 - E.g.: “Should the next target be a photometric calibration field, a science target, or something else?”
- Provide a measure of the photometric quality of an image
 - E.g.: “This image was obtained under such-and-such conditions; is it good enough to be used for photometric calibrations?”
- Detect even light cirrus for the above purposes under a full range of moon phases (no moon to full moon)



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SkyCam Functional Overview

The Sky Camera system should*:

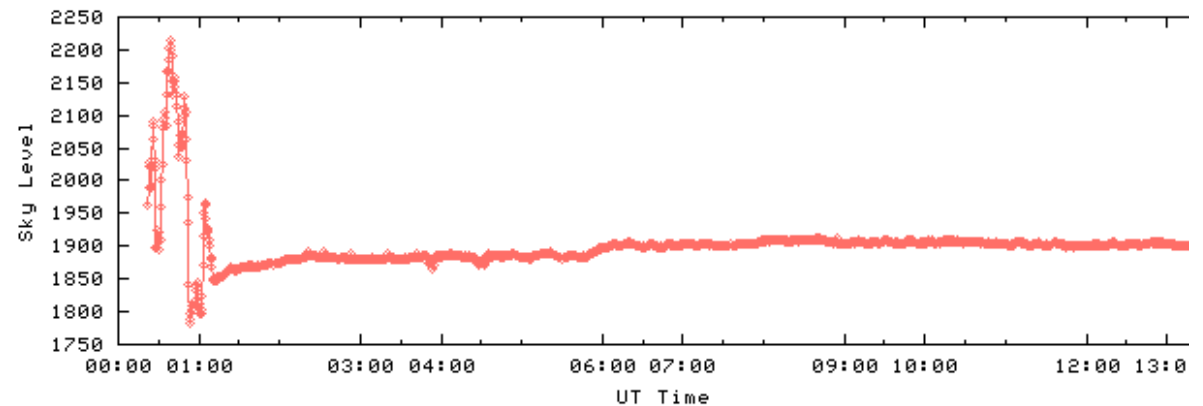
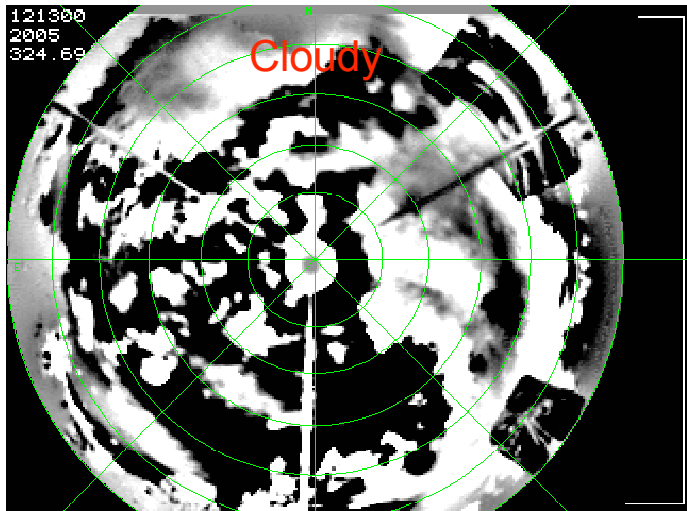
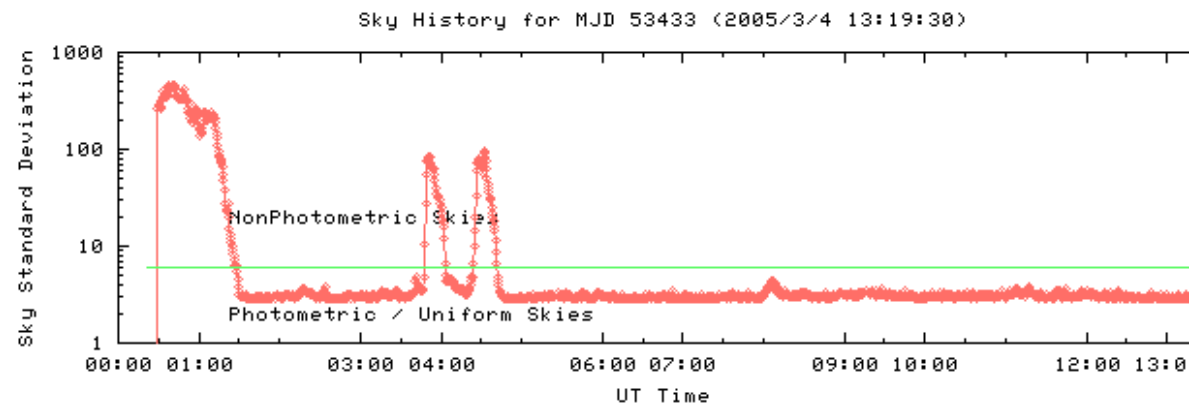
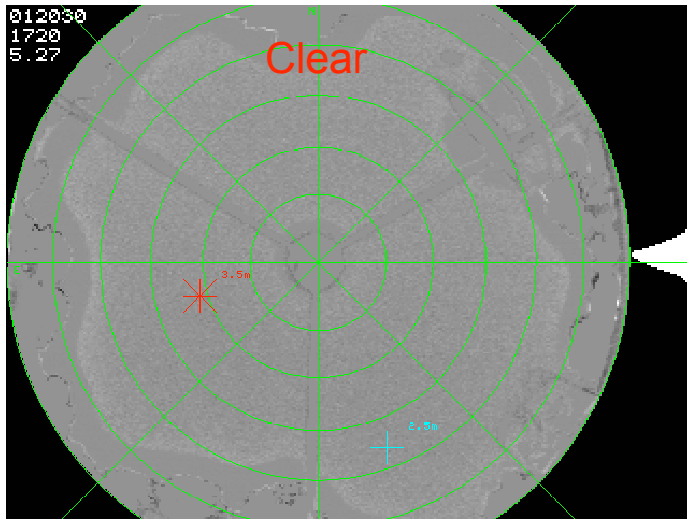
1. Image the full sky at a wavelength of ~ 10 microns once every 30 seconds throughout the course of nightly operations of the Blanco 4.0m telescope.
2. Process the images in real-time.
3. Output in real-time a GIF version of the processed image to a webpage.
4. Output in real-time a quantitative diagnostic indicating the cloudiness of the sky (e.g., the rms of the pixel values from the most recent processed image) to a web-accessible graph and to an archival database.
5. Create an animation based upon the processed images from the past hour to detect cloud movement, and output this animation to a webpage.
6. Create an animation based upon the full night's processed images at the end of each night.
7. Archive the raw and processed FITS images, processed GIF files, and the full-night animation to a web-accessible directory.

*Based upon the functionality of the APO 10 micron all-sky camera, which, in its current incarnation has been operating successfully since 2001.



APO 10 micron All-Sky Camera Output

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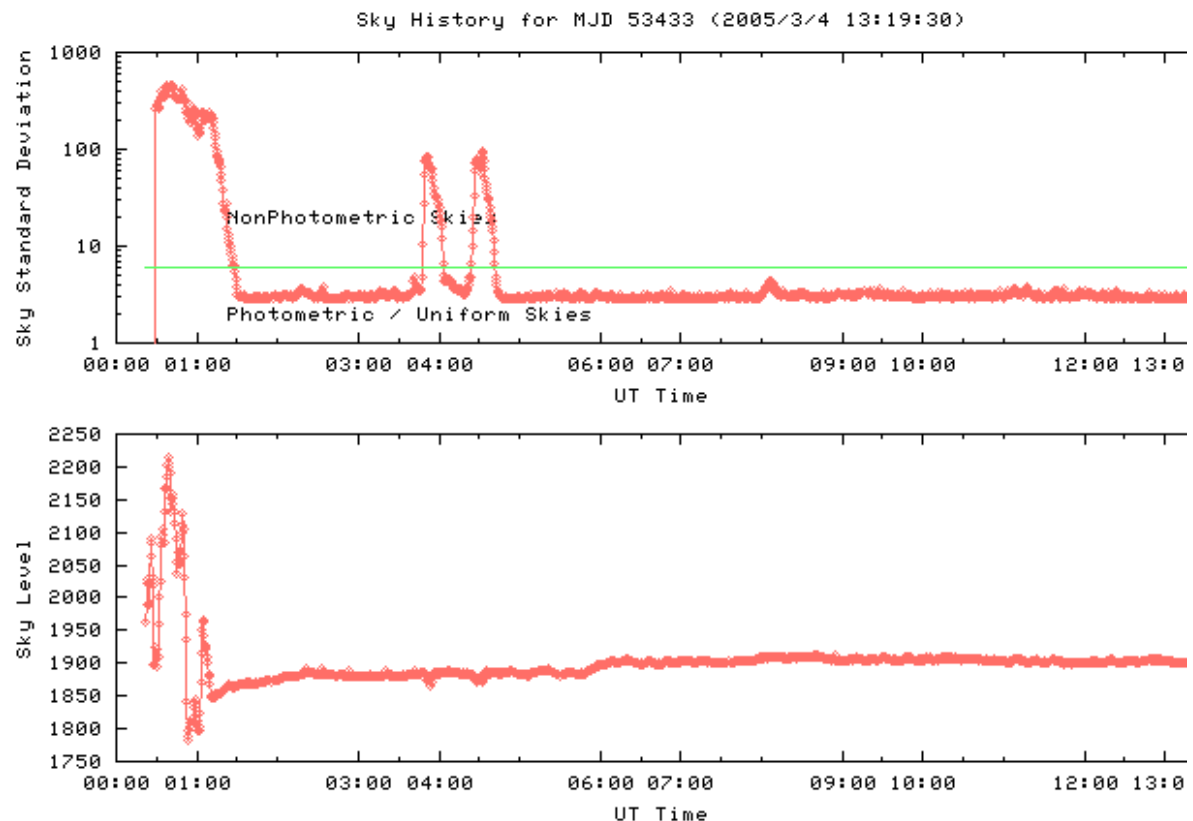


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Proposed SkyCam DB Inputs

SkyCam table in DB:

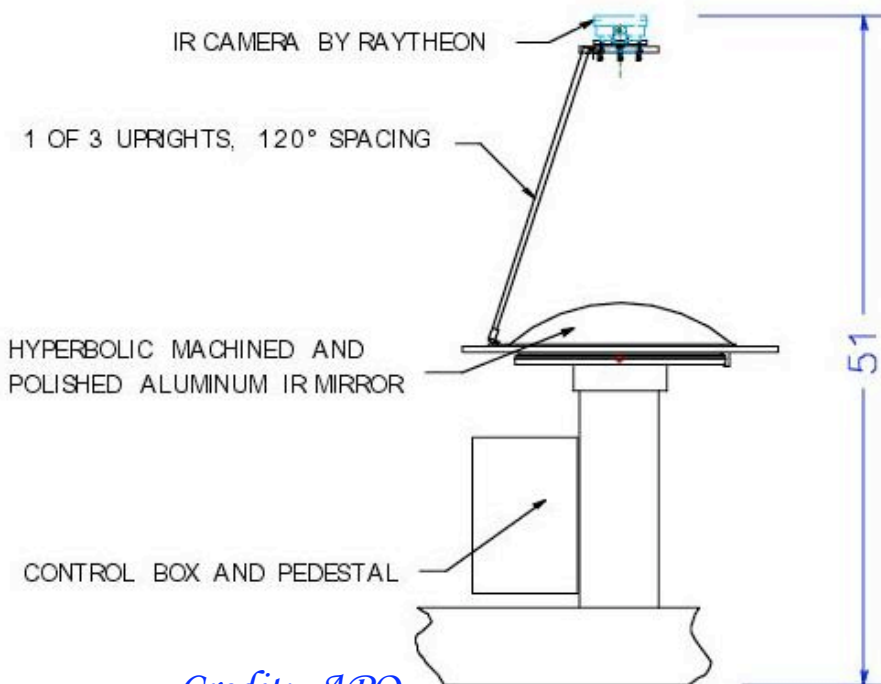
- Date & Time Stamp (UT/TAI)
- mean sky brightness
- std dev of sky brightness
- “photometricity” flag (0/1)
(or threshold value of the std dev of sky brightness considered photometric)
- name of associated SkyCam FITS images (raw and processed)





APO 10 micron All-Sky Camera Hardware

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Credit: APO

Design of the current APO 10 micron all-sky camera, commissioned in 2001



Credit: APO

A photograph of the APO 10 micron all-sky camera



SkyCam Disk Space Needs (Assuming APO Design)

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- Image size: 320 pixels x 240 pixels
 - 16-bit FITS images
 - 150KB per FITS image
- 1 FITS image every 30 seconds
 - 12 hours per night operation
 - 1440 FITS images per night
 - $1440 \text{ FITS images/night} \times 150\text{KB} / \text{FITS image} = 211\text{MB} / \text{night}$
- Saving all images in GIF and animated GIF format as well as FITS format could conceivably triple the disk space requirements
- Ancillary files (like nightly QA plots and logs) may only add an additional 1 MB per night or so to the archive
- $3 \times 211\text{MB} / \text{night} \sim 630 \text{ MB} / \text{night}$
- Annual storage requirements $\sim 630 \text{ MB} / \text{night} \times 365 \text{ nights} \sim 225 \text{ GB}$



APO Design Cost Estimate*

(29 December 2007)

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Raytheon "Thermal Eye" 300D 10-micron camera	\$8,000
Video-to-optical fiber converters (E.g., Opticomm MMV-110 Mini XMT, RCV pair)	2x\$275
Frame grabber (E.g., Hauppauge WinTV 191)	\$100
Pentium Desktop with 1-GB RAM and 250 GB HD	\$3,000
External 250 GB HD (backup)	\$250
18-inch-diameter hyperbolic mirror (machined aluminum)	\$3000
Camera support structure and enclosure (Base plate, canopy, mount plate/strut assembly)	\$2000
Paint assembly titanium white epoxy	\$400
Polish the aluminum mirror	1 FTE Day
TOTAL	\$17,300 + 1 FTE Day

*Based upon information from the APO IRSC documentation page, http://irsc.apo.nmsu.edu/irsc_doc/, and from e-discussions with Mike Carr.



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SkyCam Timeline

Finalize design and start obtaining quotes for materials	Mar 1, 2008
Start constructing SkyCam and writing SkyCam software	Sep 1, 2008
Start commissioning SkyCam and SkyCam software	Mar 1, 2009
Complete commissioning SkyCam and SkyCam software	Sep 1, 2009
Start DES	Sep 1, 2010



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*And that is how matters stood until
October 2007...*

LSST Cloud Camera Design

IR All-Sky Camera

Visible Camera
under dome

IR Camera
under hatch



IR camera with 180deg cone angle lens



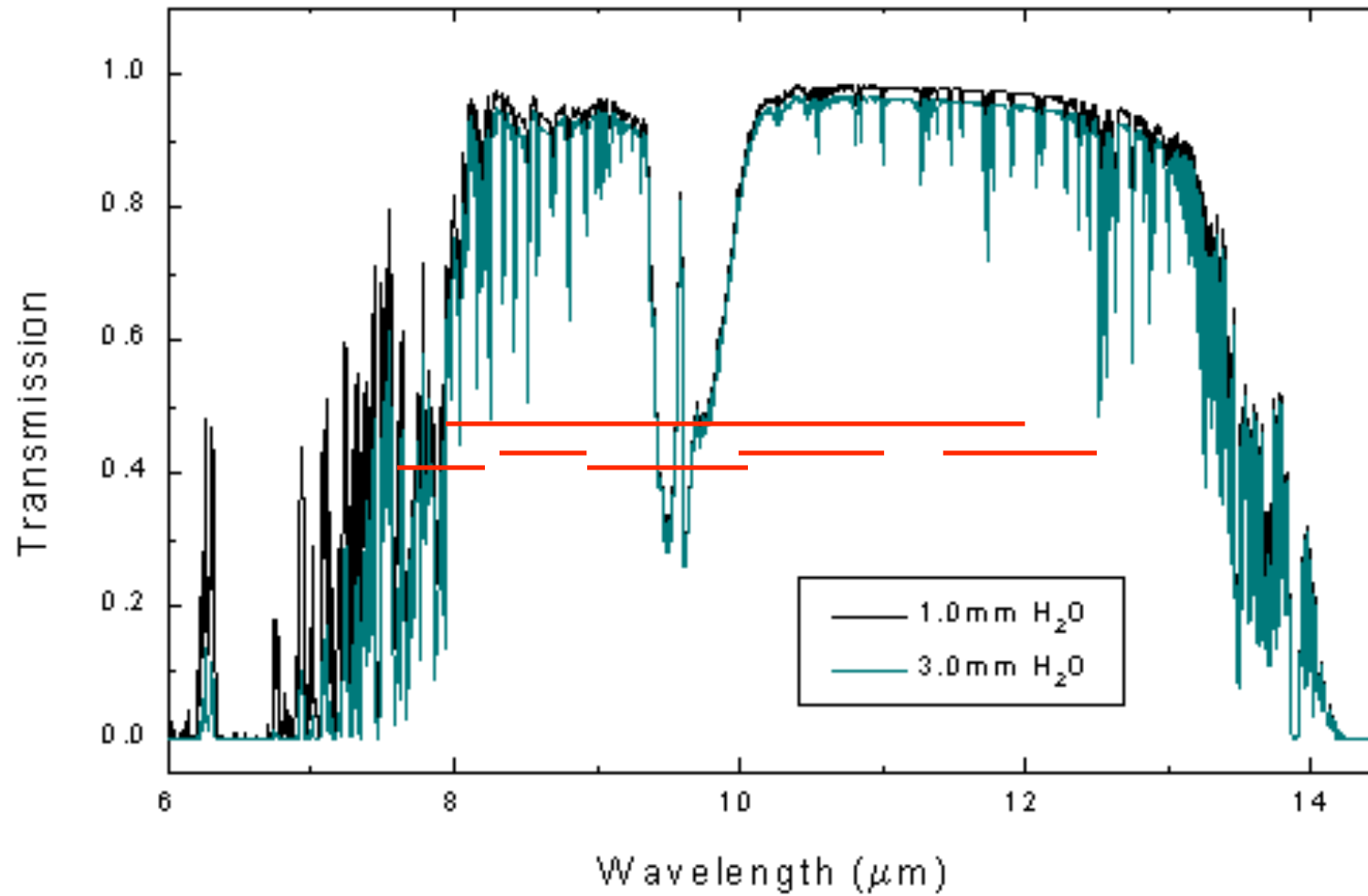
Black Body located
inside hatch

- Deployment in Chile around mid 2007
- Comparison of IR images with SASCA images

Slide Credit: Jacques Sebag

LSST Cloud Camera Design

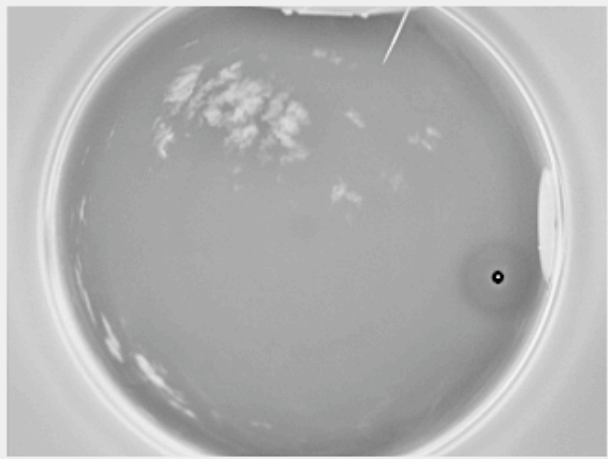
mid-IR Sky Transmission



Slide Credit: Jacques Sebag

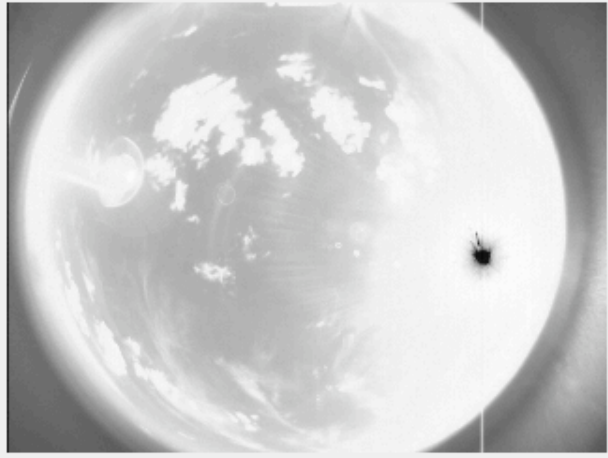
File Mode Help

Raw Image: updated 2007-09-27 22:40:52

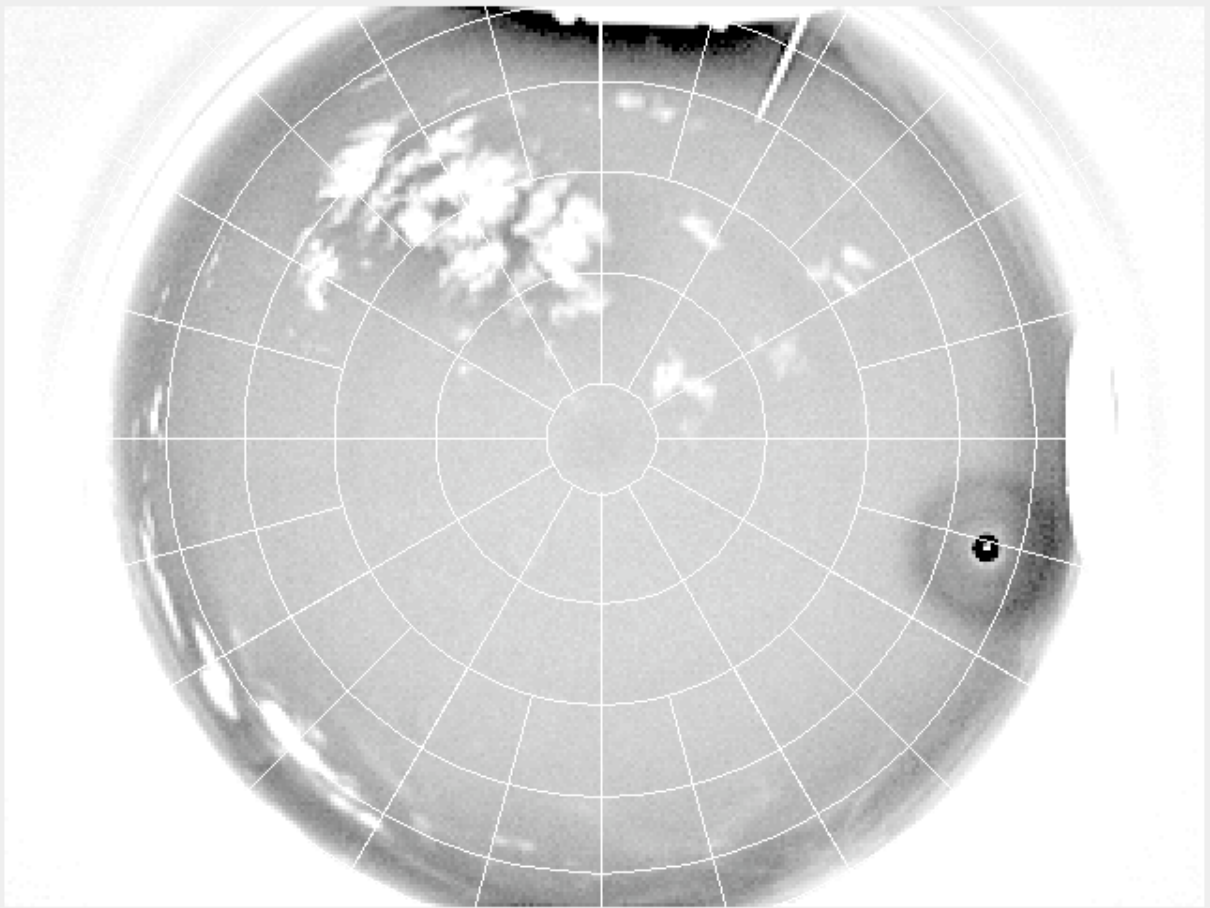


Current Filter: 4

Visible Image: updated 2007-09-27 22:38:55



Processed Image [Black Body Subtracted]



Start Stop

System Status

```
>> START: auto-calibration sequence
Starting calibration sequence
```

Zone #: 83

(x, y): 132, 406

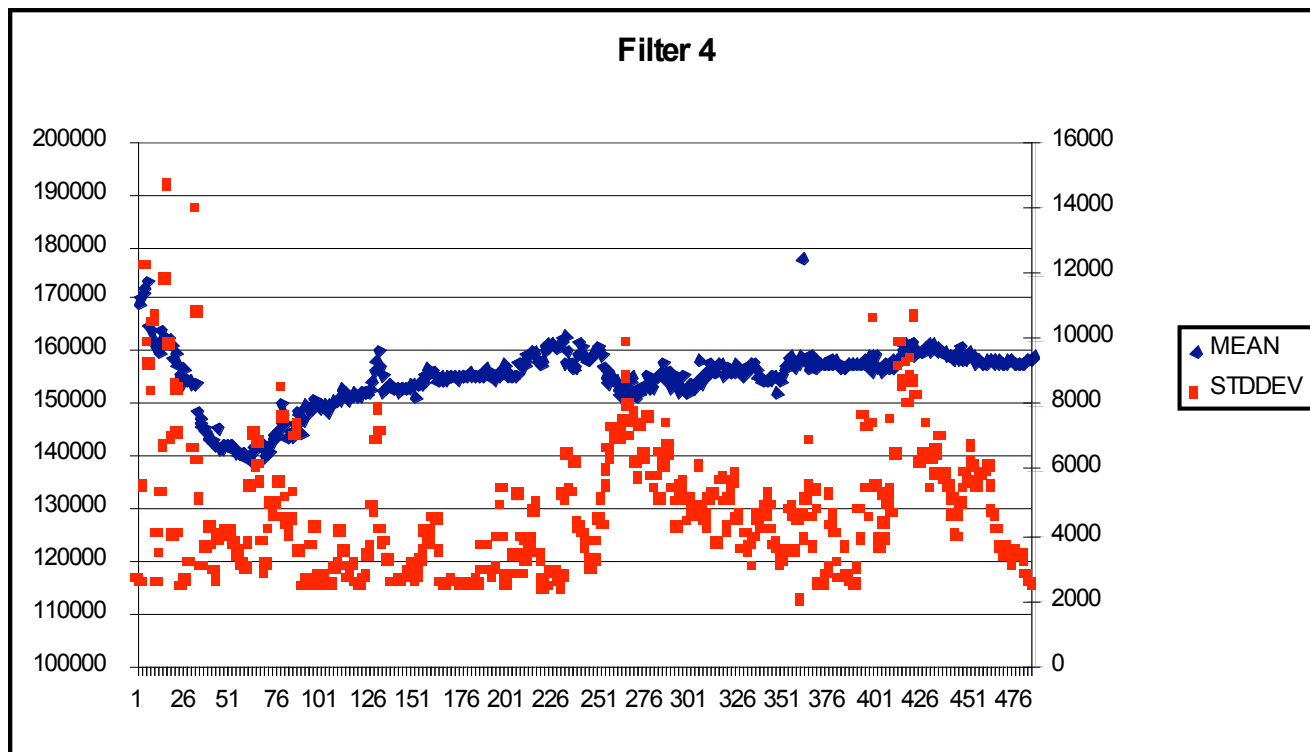
(alt, azi): 51.84, 136.27

Raw Value: 169010

LSST Cloud Camera Design

Kitt Peak Run

Mean and RMS over a window $\sim 100 \times 100$ pixels centered on each filter4 image



Slide Credit: Jacques Sebag

LSST Design Cost Estimate

- Estimate provided by Jacques Sebag (NOAO):
 - System was purchased for **\$60K**, which includes the unit itself, the software, and the computer.
 - The price may have changed slightly along with small changes in the company's design of the system.



Credit: Jacques Sebag



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APO vs. LSST Designs

APO Design

Pros:

- Robust
 - in use at APO for several years
- Inexpensive
 - APO designs and software freely available
 - Materials cost < \$20K

Cons:

- 1st generation 10-micron all-sky camera
 - probably outdated by 2010
 - APO itself may have upgraded by then
- One of a kind camera at CTIO
 - less maintainability
 - less redundancy
 - semi-customized (not purely “off-the-shelf”)
- Not flux calibrated

LSST Design

Pros:

- High level of maintainability
 - duplicate of camera to be sited on Cerro Pachon for SOAR and LSST
- Partial redundancy
 - Although not ideal, if one of the two cameras fails, one can use the outputs from the camera on the other mountain as a temporary “stop-gap” solution
- Several filters + optical all-sky camera → more sky diagnostics
- “Blackbody on Board” → flux calibration
- More-or-less “off-the-shelf”

Cons:

- More expensive (~\$60K)
 - Cost sharing with CTIO can mitigate the expense to DECAM.
- Sky diagnostics still under development
- So far, limited use under field conditions